National Aeronautics and Space Administration

Next-Generation Communications

Demonstrating the World's First X-ray Communication System

About the Technology

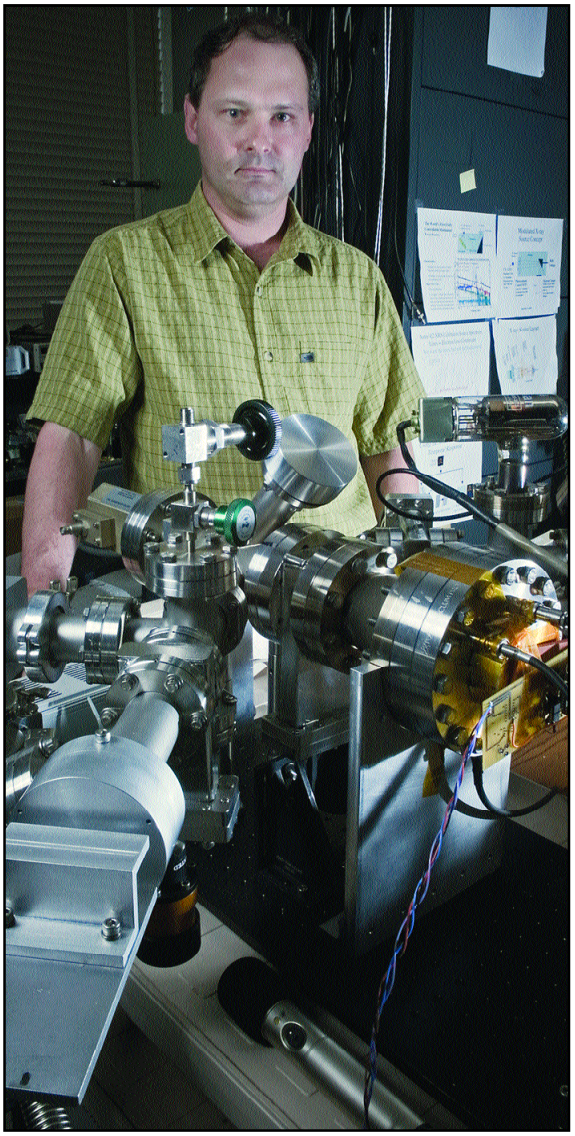
A Goddard technologist has demonstrated the world's first X-ray communication system using a Modulated X-ray Source (MXS) developed with Goddard R&D funds. With additional Internal Research and Development funding, the inventor is integrating the system with X-ray optics to demonstrate a full system-level concept, with the hope of increasing the system's data rate of 50 kbps to 1 Mbps.

Testing began in the fall of 2007 at Goddard's X-ray Interferometry Testbed, using the facility's 600-meter vacuum beamline. The goal is to some day transmit gigabytes of data per second using minimal power.

Significance of the Technology

Communication via X-rays offers significant advantages to both civilian and military space programs. Although currently at a very low technology-readiness level, it has the potential to provide high-data rates at low power over vast distances in space. In addition, such a communication system could penetrate RF shielding on the ground and communicate with hypersonic vehicles during that short period of time when the build-up of heat during reentry blocks traditional communications signals.

Although the inventor conceived the technology while attempting to create a technological solution for a proposed NASA science mission, the Defense Advanced Research Projects Agency (DARPA) has since learned of the project. DARPA and also has invested R&D funding into its development.



In his attempt to create a technology necessary for the proposed Black Hole Imager, Goddard's Keith Gendreau demonstrated the world's first X-ray communication system.

See reverse side

goddard technology

Benefits of the Technology: At-A-Glance

- Promises to carry large amounts of data using little power.
- Offers the potential to rival its laser counterpart over long distances in space.
- Penetrates RF shielding on the ground.
- Communicates with hypersonic vehicles or reentering spacecraft.
- Overlaps with research into navigation using X-ray pulsars.

How the Technology Works

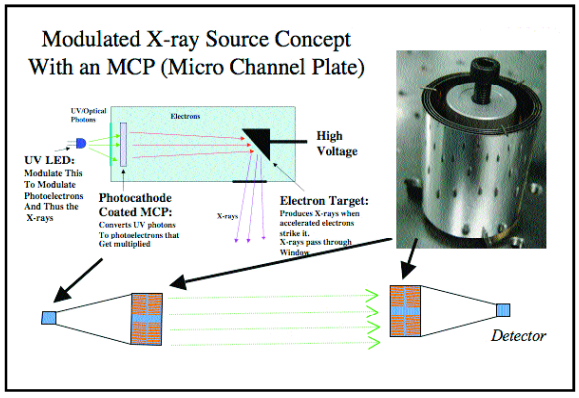
The technology is enabled by the MXS, created with R&D funding as a means to modulate the intensity of the X-ray source to follow arbitrary waveforms using the photoelectric effect. Amplitude modulation on sub-nanosecond scales is possible. Future versions will allow for sub-nanosecond X-ray energy changes.

Technology Origins

The inventor began work on the technology several years ago when attempting to develop a technological solution for NASA's proposed Black Hole Imager. The idea was to establish a constellation of precisely aligned spacecraft. Making sure the spacecraft maintained their position was the challenge the inventor tried to address. He conceived the idea of using X-ray sources as beacons to enable highly precise relative navigation and then modulating the X-rays to create a communication system out of the navigational beacons.

Looking Ahead

With additional NASA and Defense Department funding, the inventor hopes to evolve the technology. Future X-ray communication systems will incorporate more efficient communication algorithms that take advantage of the large signals expected from individual X-ray photons. Integration of full systems using X-ray diffraction-limited optics will potentially enable revolutionary data rates over interplanetary distances. Also, modifications of the basic design can lead to the potential of high-speed switching of the X-ray energies emitted by the MXS, which will open up new channels of communication.



This schematic shows the concept for modulating X-rays to create a communication system. With this approach, the principal investigator hopes to increase the data rate of his X-ray communication system from 50 kbps to 1 Mbps.

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